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Claims

[c1] 1. A method of creating a tooling master model for a manufacturing process for a part, the tooling master model comprising a tooling geometry for the part, said method comprising:
generating a manufacturing context model from a parametric model for the part, the manufacturing context model comprising a plurality of tooling features.

[c2] 2.The method of Claim 1, wherein the parametric model includes a plurality of geometric dimensions and tolerances (GD&T).

[c3] 3.The method of Claim 2, wherein the manufacturing process comprises at least one manufacturing step, and wherein said generation of the manufacturing context model comprises:
orienting the parametric model using the geometric dimensions and tolerances to obtain an oriented GD&T model; and
applying a plurality of manufacturing design rules to the oriented GD&T model to obtain the manufacturing context model for the manufacturing step.

[c4] 4.The method of Claim 3, wherein the manufacturing process further comprises at least one additional manufacturing step, and wherein said generation of the manufacturing context model further comprises:
orienting the manufacturing context model to obtain the oriented GD&T model; and
applying the manufacturing design rules to the oriented GD&T model to generate the manufacturing context model encompassing the additional manufacturing step, wherein said orientation and application are performed for each of the additional manufacturing steps.

[c5] 5. The method of Claim 3, wherein the manufacturing design rules include a plurality of tooling design rules, and wherein the method further comprises:
applying the tooling design rules to the manufacturing context model to obtain the tooling master model, wherein the tooling geometry is derived from the tooling features by said application of the tooling design rules.

[c6] 6.The method of Claim 5, further comprising creating at least one tooling context model comprising an associative copy of the tooling master model which is configured for performing a manufacturing process analysis.

[c7] 7.The method of Claim 6, wherein at least two tooling context models are created, each of the tooling context models being configured for performing a different manufacturing process analysis.

[c8] 8.The method of Claim 5, further comprising preparing the tooling context model for performance of the manufacturing process analysis, said preparation comprising:
meshing the tooling context model using the analysis code guidelines to obtain a meshed tooling model, and
mapping a plurality of boundary conditions onto the meshed tooling model using the analysis code guidelines to obtain a tooling analysis model.

[c9] 9.The method of Claim 8, further comprising:
performing the manufacturing process analysis on the tooling analysis model to obtain tooling analysis data, said performance comprising executing a manufacturing process analysis code using the tooling analysis model, a plurality of convergence criteria, and a plurality of process parameters;
evaluating the tooling analysis data and, if the tooling analysis data are unsatisfactory, said method still further comprising:
modifying the tooling master model using a plurality of manufacturing goals tooling design tradeoffs; and
repeating said performance of the manufacturing process analysis after modifying the tooling master model.

[c10] 10.The method of Claim 5, further comprising adding a plurality of geometric dimensions and tolerances (GD&Ts) to the tooling master model.

[c11] 11.A system for generating a tooling master model for a manufacturing process for a part, the tooling master model comprising a tooling geometry, said system comprising:
a computer aided design (CAD) system configured to receive a parametric model and to generate a manufacturing context model from the parametric model, the manufacturing context model comprising a plurality of tooling features.

[c12] 12.The system of Claim 11, wherein the manufacturing process comprises at least one manufacturing step, wherein said CAD system is further configured to orient the parametric model after processing with a plurality of geometric dimensions and tolerances to obtain an oriented GD&T model, and wherein said system further comprises:
a knowledge based environment configured to apply a plurality of manufacturing design rules to the oriented GD&T model to obtain the manufacturing context model for the manufacturing step.

[c13] 13.The system of Claim 12, wherein said CAD system is further configured to process the

parametric model with a plurality of producibility data to add the geometric dimensions and tolerances to the parametric model.

[c14] 14.The system of Claim 12, wherein the manufacturing process comprises at least one additional manufacturing step, wherein said CAD system is further configured to orient the manufacturing context model to obtain the oriented GD&T model,
wherein said knowledge based environment is configured to apply the manufacturing design rules to the oriented GD&T model to generate the manufacturing context model encompassing the additional manufacturing step, and
wherein said CAD system and said knowledge based environment are further configured to perform the orientation and application, respectively, for each of the additional manufacturing steps.

[c15] 15.The system of Claim 12, wherein the manufacturing design rules include a plurality of tooling design rules, wherein said knowledge based environment is further configured to apply the tooling design rules to the manufacturing context model, and wherein said CAD system is further configured to derive the tooling geometry from the manufacturing context model using the tooling design rules, to generate the tooling master model.

[c16] 16.The system of Claim 15 further comprising:
a linked model environment configured for creating at least one tooling context model, wherein the tooling context model comprises an associative copy of the tooling master model and is configured for performing a manufacturing process analysis; and
a manufacturing process analysis code for performing the manufacturing process analysis to generate tooling analysis data for evaluating the tooling master model.

[c17] 17.The system of Claim 16, further comprising a part data management (PDM) system configured to store operating condition data for deriving a plurality of boundary conditions and a plurality of process parameters,
wherein said linked model environment is configured to link said PDM system:
to a meshed tooling model obtained from the tooling context model, to map the boundary conditions onto the meshed tooling model, and
to the manufacturing process analysis to supply the process parameters for performing the manufacturing process analysis.

[c18] 18.The system of Claim 15, wherein said CAD system is further configured to add a plurality of geometric dimensions and tolerances (GD&Ts) to tooling master model.

[c19] 19.A method of manufacturing comprising:

generating a manufacturing context model for a manufacturing process for a part from a parametric model, the manufacturing context model comprising a plurality of tooling features;

creating a tooling master model from the manufacturing context model, the tooling master model comprising a tooling geometry for the part;

generating a hard tooling using the tooling master model; and

manufacturing at least one part using the hard tooling and a plurality of process parameters.

[c20] 20.The method of Claim 19, wherein the manufacturing process comprises at least one manufacturing step, and wherein said generation of the manufacturing context model comprises:

orienting the parametric model with a plurality geometric dimensions and tolerances to obtain an oriented GD&T model, and

applying a plurality of manufacturing design rules to the oriented GD&T model to obtain the manufacturing context model for the manufacturing step,

wherein the manufacturing design rules comprise a plurality of tooling design rules.

[c21] 21.The method of Claim 20, wherein the manufacturing process further comprises at least one additional manufacturing step, and wherein said generation of the manufacturing context model further comprises:

orienting the manufacturing context model to obtain the oriented GD&T model; and

applying the manufacturing design rules to the oriented GD&T model to generate the manufacturing context model encompassing the additional manufacturing step, wherein said orientation and application are performed for each of the additional manufacturing steps.

[c22] 22.The method of Claim 20, wherein said creation of the tooling master model comprises applying the tooling design rules to the manufacturing context model to obtain the tooling master model, wherein the tooling geometry is derived from the tooling features by said application of the tooling design rules.

[c23] 23.The method of Claim 22, further comprising:

creating at least one tooling context model comprising an associative copy of the tooling master model which is configured for performing a manufacturing process analysis;

preparing the tooling context model for performance of the manufacturing process analysis;

performing the manufacturing process analysis to obtain tooling analysis data;

evaluating the tooling analysis data and, if the tooling analysis data are unsatisfactory, said

method still further comprising:

modifying the tooling master model using a plurality of manufacturing goals tooling design tradeoffs; and

repeating said performance of the manufacturing process analysis after modifying the tooling master model.

[c24] 24.The method of Claim 22, further comprising adding a plurality of geometric dimensions and tolerances (GD&Ts) to tooling master model.

[c25] 25.The method of Claim 24, further comprising:

inspecting at least one part manufactured using the hard tooling to obtain measurement data; and

assessing the measurement data to determine whether the part manufactured satisfies a plurality of engineering criteria for the part.

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